Page 5, line 26 - page 9, line 2

In this case, according to the present invention, the heat generation means may be formed such that the part adjacent to the next is varied in different positions in the direction of thickness of the ceramic substrate. In the case where a thermal shock is applied to cause the expansion or shrinkage when heating up or cooling down respectively, the expansion or shrinkage at each part in the heat generation means is dispersed to mutually different planes so as to avoid an excessive stress concentration.

In this case, according to the present invention, the heat generation means may be of the sectional form of flat-profile.

In this case, according to the present invention, the amount of offset at the mutually adjacent sections may preferably be in the range of 1 to 100 μm. In such a range, the effect of thermal shock may be finely dispersed in the direction of thickness of the ceramic substrate and to be reduced. Here it should be noted that the amount of 'offset' may be defined as the distance between the center points in the direction of thickness of the ceramic substrate, by polishing the section of the ceramic substrate and determining the crossing points of diagonal lines across the corners in the section of the heat generation means as the center point by means of an optical microscope or an electron microscope (see δt of Fig. 1B).

In this case, as according to the present invention, the maximum amount of offset of the locations may preferably be in the range of 3 to 500 μm. The maximum amount of offset less than 3 μm is insufficient to have an effect of disperse the expansion or shrinkage of the ceramic substrate, while on the other hand the maximum amount of offset more than 500 μm may invoke another problem of uniformity of thermal distribution on the surface of the ceramic heater. Here it should be noted that the 'maximum amount of offset' may be defined by the distance δtmax in the direction of thickness between the lowest level and the highest level as shown in Fig. 2; that the amount of offset between mutually adjacent parts (of heat

generation bodies) may be defined by the distance δt in the direction of thickness between the cross-sectional center points of 'mutually adjacent parts (of heat generation bodies)' as shown in Figs. 1A, 1B and Fig. 9F.

In addition, the heat generation means may be formed from a spiral wire body.

In this case, the maximum amount of offset of the locations may be preferably in the range of 5 to 2000 μm. The maximum amount of offset less than 5 μm may be insufficient to have the effect of offset, while the amount more than 2000 μm may arise another problem of uniformity of thermal distribution on the surface of the ceramic substrate. Here the 'maximum amount of offset' in case of spiral form, may be defined as the distance between the lowest level and the highest level of the center points in the direction of thickness of the ceramic substrate, which center points may be determined by treating the cross-section as a circle or a oval to define as the distance between the lowest level and the highest level of the center points in the direction of thickness of the ceramic substrate (see Fig. 9F), however if the spiral form is considered to be a continuity of circles having the same diameter of cross-section, or to be a continuity of ovals having the same diameter in shorter axis as in longer axis, the maximum value may be defined as the amount of offset at the top or bottom edge of the spiral. Also it should be noted that the amount of offset between 'mutually adjacent parts (of heat generation body)' may be defined as the distance between the center points of the mutually adjacent heat generation bodies.

In this case, electrostatic electrodes may be provided on the ceramic substrate. The ceramic heater in accordance with the present invention may thereby be used as an electrostatic chuck. In addition, a chuck-top conductor layer may be formed on top of the surface of the ceramic substrate. The ceramic heater in accordance with the present invention may thereby be used as a wafer probe.

Page 10, line 3 - page 11, line 21:

Figs. 1A and 1B are cross-sectional side elevation views showing primary parts of a ceramic substrate of a ceramic heater in accordance with an embodiment of the present invention;

Fig. 2 is a cross-sectional side elevation view showing primary parts of a ceramic substrate of a ceramic heater in accordance with an embodiment of the present invention;

Fig. 3 is a cross-sectional side elevation view showing primary parts of a ceramic substrate of a ceramic heater in accordance with an embodiment of the present invention;

Fig. 4 is a cross-sectional plan view showing primary parts of a ceramic substrate of a ceramic heater in accordance with an embodiment of the present invention;

Figs. 5A and 5B show schematic diagrams of processes for obtaining the positional offset of heat generation bodies in a ceramic substrate of a ceramic heater in accordance with an embodiment of the present invention;

Figs. 6A to 6C are schematic plan views showing the disposition of paste layers in a ceramic substrate of a ceramic heater in accordance with an embodiment of the present invention, in the order of lamination;

Figs. 7A to 7C show schematic diagrams of processes indicating the disposition of paste layers in a ceramic substrate of a ceramic heater in accordance with an embodiment of the present invention, in the order of lamination, and Fig. 7D shows a cross-sectional side elevation view after the lamination thereof.

Figs. 8A to 8D show flow diagrams of production of ceramic substrate in accordance with an embodiment of the present invention;

Figs. 9A to 9F show flow diagrams of production of ceramic substrate in accordance with another embodiment of the present invention;

Fig. 10 shows a schematic diagram of electrodes for an electrostatic chuck in accordance with an exemplary application of the present invention;

Figs. 11A to 11D show flow diagrams of production of wafer probe in accordance with an exemplary application of the present invention;

Fig. 12 is a graph showing the results of a bending resistance test after a thermal shock test; and

Fig. 13 is a cross-sectional side elevation view showing the primary parts of a conventional ceramic substrate.

Page 12, line 2 - line 14:

In Figs. 1A to 3, there are shown cross-sectional elevation views of a ceramic substrate 12 of a ceramic heater 10 in accordance with the present invention, which are cross-sectional side elevation views in which the ceramic substrate 12 is cut in the direction of thickness t, in a plane perpendicular to the longitudinal axis of heat generation bodies 14, 16, 18 and 20, which are in the form of ribbons with a width. Fig. 4 depicts in a schematic manner the planar conductor patterns of the heat generation bodies 14, 16, 18 and 20, by showing a cross-sectional plan view of a horizontal plane including the upper surface of the heat generation bodies 14, 16, 18 and 20 (i.e., Pla, Pla' in Fig. 1A and 7B; P2b P2b' in Fig. 2; P3b P3b' in Fig. 3, and the like).

Page 13, line 8 - page 14, line 11

In this case, it is preferable for the heat generation means that the amount of offset at the mutually adjacent spiral section is in the range of 1 to 500 μm.

Now each of preferred embodiments shown in Figs. 1A to 3 will be respectively described below in greater details.

The heat generation body 14 shown in Fig. 1A is comprised of a heat generation body 14a and heat generation body 14b, which are disposed at mutually adjacent position, and each of heat generation bodies 14 is disposed so as to be coaxial in plan view (see Fig. 4) in the planes Pla and Plb within the ceramic substrate 12. The level of plane Pla and that of Plb are

mutually offset at the amount of offset δt in the direction of thickness t. That is, the ceramic heater 10 is arranged in the direction of thickness t of the ceramic substrate 12 such that the amount of offset of the mutually adjoining heat generation bodies H may be in the range of 1 to 100 μm. This arrangement may allows the effect of thermal shock to be buffered more finely in the direction of thickness of ceramic substrate. The heat generation bodies H are arranged so as to have 5 to 50 μm of thickness. In this arrangement the expansion or shrinkage of the heat generation bodies H at the time of heating or cooling of ceramic substrate 12 may be occurred in the plane Pla and plane Plb, which are mutually offset each from other by an amount δt. This helps dispersion of stress. In the case where the heat generation body is in the spiral form, the heat generation means may preferably have an amount of offset in the mutually adjoining spiral section in the range of 1 to 500 μm.

Page 15, lines 12-25:

In the case where the heat generation body 16 is arranged as shown in Fig. 2, then for the heat conducting to the entire ceramic substrate 12, the distance from the heating surface to the heat generation body 16c and 16d may differ from the distance to the heat generation body 16a and 16b, that is, the heat generation body nearer to the outer circumference may be disposed nearer to the heating plane. This allows the temperature around the outward periphery to be prevented from decreasing. On the contrary, in the case where the heat generation bodies 16 are arranged to be convex to upper side (see Figs. 8A to 8D), then inwardly disposed bodies may be nearer to the heating plane so that the decrease of temperature in such inward section may be prevented even if the electrodes are connected beneath the inward heat generation bodies.

Page 17, lines 3-25:

As can be seen from the foregoing discussion, in accordance with the arrangement shown in Figs. 1A through Fig. 3, the heat generation bodies 14, 16, 18 and 20 may be

located such that at least some of heat generation bodies H are offset from others in terms of the direction of thickness t of the ceramic substrate 12. In this arrangement when heating or cooling the ceramic substrate 12, the expansion or shrinkage of the heat generation bodies H may be occurred on the planes that are mutually set off each other by the amount of offset δt, or on the planes that are mutually offset each other by the amount of offset δt and that the maximum amount of offset between farthest planes is δt_{max}. Thus the ceramic heater 10 may be able to disperse the effect of thermal shocks into the direction of thickness t of the ceramic substrate 12 while at the same time able to maintain the uniformity of heating over the entire ceramic substrate 12.

The configuration of the ceramic heater 10 may not be limited to the above-mentioned embodiment. For example, the ceramic heater 10 may be arranged such that some of heat generation bodies H is displaced along with the longitudinal axis of the heat generation bodies H, on the horizontal level (see Figs. 7A to 7D).

Page 18, line 5 - line 9:

Referring to Figs. 5A and 5B, there is shown a schematic diagram illustrating a method of producing a ceramic heater, in which a heat generation body Ha is disposed offset from another heat generation body Hb. The arrangement shown in this figure is prior to baking.

Page 24, line 5 - line 12:

Next, the process of applying paste layers and the process of laminating and pressurizing will be described below. Referring to Figs. 6A to 6C, there is shown a plan view showing primary layers when laminating green sheets in the order of 6A to 6C from the topmost layer. Fig. 6A shows only a paste layer configured according to the arranging pattern. This patterned layer 28a will be superposed on the heat generation body Ha shown in Fig. 6B.

Page 27, lines 11-23:

Referring to Figs. 7A to 7D, a configuration with some of heat generation bodies being produced in positions offset along with the longitudinal axis of the heat generation bodies in a plane will be described below in greater details. With respect to the green sheet 32b with heat generation bodies H, in the upper surface thereof, a paste layer 34k will be formed over the heat generation bodies H in accordance with the pattern 34k; in the lower surface, a paste layer 34h will be formed on a green sheet 32c. Then, as similar to the case shown in Fig. 5B, other green sheets will be superposed thereon to produce the green sheet laminated body 32 as shown in Fig. 7D. The pattern 34k and the pattern of heat generation bodies H are preferably coaxial.

Page 31, line 5 - page 32, line 21:

Another embodiment of the present invention will be described below. In this embodiment, green sheet lamination is similar to the preceding embodiment, except for a mold 36 used, which has a convex or concave surface, as shown in Figs. 8A to 8D. Furthermore, a ceramic heater may be produced by adding additional five to fifty green sheets attached to both upper and lower sides, then sintering the green body under a high pressure and high temperature condition (see Figs. 8A and B) to once produce a curved ceramic substrate 40, then flattening both the upper and bottom surface by trimming (see Fig. 8C). The amount of bending in the convex or concave surface may be preferably in the range of 3 to 500 μm in order to assure the maximum amount of offset δtmax. The trimming amount may be preferably in the range of 5 to 1000 μm, in order to assure the flatness.

In Figs. 8A to 8D, through holes 42 are provided for heat generation bodies H, and terminals 44 made of cobalt or stainless steel are attached thereto (see Fig. 8D). The temperature will be decreased around the center portion due to the heat dissipation by conduction through the terminals 44. While configuration shown in Figs. 8A to 8D are

unlikely to decrease the temperature because the heat generation bodies H close to the center portion are located nearer the heating plane.

Now still another embodiment will be described with reference to Figs. 9A to 9F. Figs. 9A and B show a plan view and cross-sectional side elevation view indicating the arrangement of heat generation bodies H; Figs. 9C to E show flow diagrams indicating process of arranging heat generation bodies H. As shown in these figures, a green body 46 may be produced at first, then a groove 48 may be provided on the surface of the green body 46 (see Fig. 9C). The groove 48 may be formed by spot facing, or may be formed in the green sheet in advance. The width and depth of groove may be adjusted to the width and thickness of the (spiral) heat generation bodies H, respectively. More specifically, the width of spiral coil is 1 to 10 mm, thickness 0.1 to 2 mm, the groove should accept this coil. The aspect ratio (width/thickness) of cross-section of the coil is preferably 1 through 10 so as to assure the uniform temperature distribution over the entire wafer-heating surface. The location of heat generation bodies may be offset by changing the depth of adjacent grooves before assembly.

Page 34, line 24 - page 35, line 3:

For this example (inventive product), the pattern shown in Fig. 1A or the pattern shown in Fig. 2 was used for the arrangement pattern of heat generation bodies and paste layers.

Page 36, lines 16 - page 37, line 5:

(4) A green sheet having heat generation body pattern and conductive paste printed thereon and 30 sheets of intact green sheets were fit into a fixture having a convex plane of 500 μm height as shown in Figs. 8A to 8D. This green sheet laminated body was degreased at approximately 600°C for five hours under a nitrogen environment, hot-pressed at approximately 1890°C, pressure 14.7 MPa•s (150 kg/cm^2) for three hours to obtain a ceramic